*The seating position in the Sinclair C5 has been designed around that of a Ford Capri. The driver's eye level is the same as that in a Mini. The steering bar is located parallel to the back axle and is gripped by the driver, as shown, in the position where the hands fall naturally. The battery, with ignition switch, lies under the left-hand side of the steering bar. Overall dimensions of the C5 are: length, 1,744mm and width, 744mm. The turning circle is 5,800mm. Behind the driver is a 1ft³ boot.*

# Sinclair's pedal electric sets new standards

**Sir Clive Sinclair's success with the ZX80 and Spectrum computers had more to do with the basic concept of the no-frills package than hi-tech. Now his packaging genius has been applied to the electric car and his concept provides some lessons for the electric vehicle industry.**

Refreshing new standards in the overall design concepts of electric vehicles have been set by Sir Clive Sinclair who launched his C5 three-wheel electric "car" last week.

The C5 was originally intended to be a single-seater traffic-compatible "baby" at the bottom end of a full range of electric cars but detail parameters were quickly altered to take advantage of the Government's Electrically-Assisted Pedal Cycle Regulations 1983. Hence the vehicle is limited to 15 mile/h maximum speed, a motor rating of 250W (the legal limit), and a total weight not exceeding 60kg: it also has, as required under the regulations, a conventional cycle pedal drive and a leak-resistant battery.

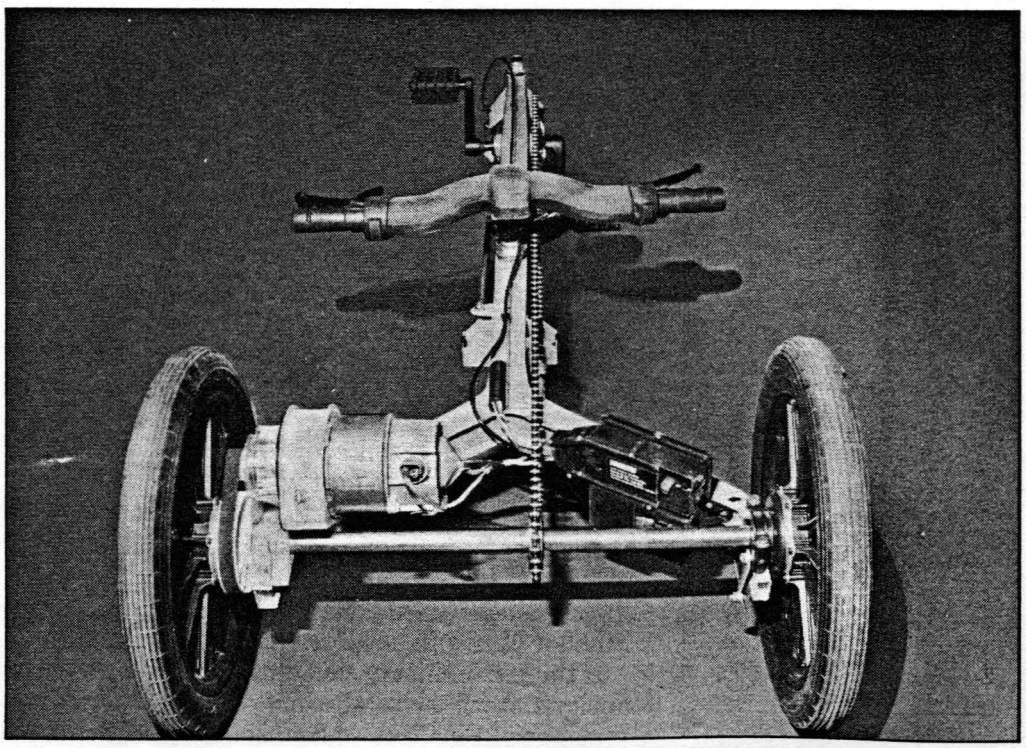
Without battery, the vehicle weighs 30kg. The single 12V 36Ah (at the 5h rate) battery supplied with the £399 car weighs 15kg giving a range of 20 miles. A second battery can be fitted without exceeding the overall weight limit and this will double the vehicle's range.

By limiting the car's performance to meet the electric pedal cycle regulations, Sinclair believes he has widened the market. But these last minute changes (he began work on the design in the early 1970s) has not affected the basic concept.

Instead of merely replacing the internal combustion engine in the traditional passenger vehicle, Sinclair considered the design of the complete package from scratch.

Since weight has an important influence on the maximum distance a battery electric vehicle can travel with a fully charged battery, the heavy steel body of the traditional vehicle was quickly dismissed. Instead an efficient pressed steel backbone chassis and low weight plastic body have been used.

The steel backbone has been developed in conjunction with Lotus Cars, who concentrated not only on proving performance but



*The motor drives the nearside rear wheel (the offside freewheels) through 13:1 two-stage glass-reinforced nylon gear train and a toothed belt to reduce noise and avoid expensive lubrication systems. The vehicle has caliper brakes on the front wheel and a drum brake on the rear offside wheel. The front caliper brake is also used for parking. The pressed-steel spinal Y-configuration chassis was developed by Lotus Cars.*

also on developing the steering geometry, chassis compliance and tyre design and pressures to ensure predictable handling characteristics.

The Y-configuration chassis is made from high grade corrosion protected steel—it is light but robust.

The C5's body assembly, which is also light and robust, consists of two large polypropylene injection mouldings by Linpac from ICI material. These are joined together by applying conductive tape to the joint and passing an electric current which causes local melting of the plastic and a permanent weld.

The body shape is the result of exhaustive wind tunnel tests at Exeter University. It includes housings for the lamps and reflectors, and a moulded boot.

Sinclair disagrees with the commonly accepted philosophy that wind resistance below 30 mile/h does not matter. He says that when a cyclist is travelling at 20 mile/h, 90 per cent of the cyclist's effort is used to overcome wind resistance. Hence the C5's body shape was designed to minimise the drag factor.

For the drive electrics, Sinclair has gone for conventional technology based on lead acid cells. However, the battery and motor have been especially developed for maximum efficiency.

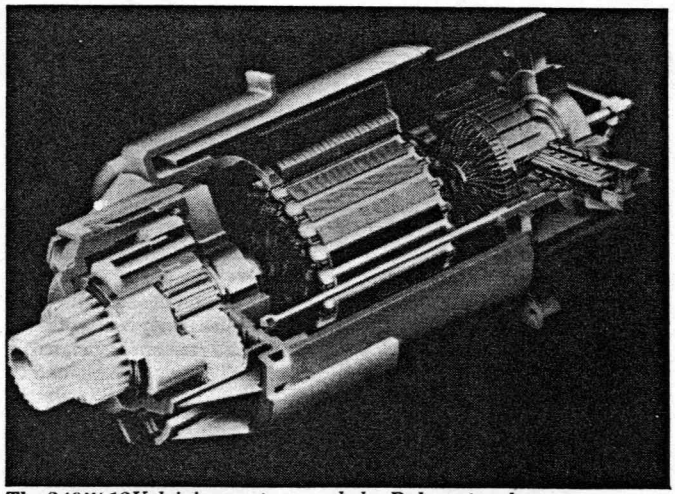
The 36Ah 12V battery has a polypropylene case only 23mm by 136mm by 206mm and weighs only 15kg. It has been developed jointly by Sinclair Vehicles and Oldham for 300 cycles deep-discharge and is priced at £34.95. It is guaranteed for 12 months. The charger, which comes with the car, will fully recharge a flat battery in 8 hours.

Contrary to some press reports, the motor is not a development from a washing machine. Rather its design derives from servo motors. It is a permanent magnet machine specially designed, developed and manufactured by Polymotor of Italy (a Philips subsidiary) for the C5. Rated at 250W 29A 12V 3,300 rev/min, the peak current is 140A. More importantly it has an efficiency of over 80 per cent, which is at least 10 per cent better than the heavy d.c. series motors used in most of the traditional electrical vehicles.

While none of these basic concepts are new, Sir Clive has set the first logical commercial standards covering the basic design principles for e.vs—minimum dead weight, low drag and a drive of maximum efficiency.

Maybe the old-established electrical vehicle industry will at last have the courage to follow suit.

Sir Clive deliberately chose to apply his e.v. concept first to the smallest, simplest and cheapest car because of its wide market and mass production potential.



*The 240W 12V driving motor, made by Polymotor, has an efficiency of over 80 per cent.*

The C5 is by far the simplest, cheapest, non-polluting, noiseless personal transport ever devised. Anyone over the age of 14 can drive it on the road without a licence, helmet or road tax. There is no clutch or gearchange and apart from understanding the controls (bicycle brakes and motor switch) no one needs driving lessons. Running costs are equivalent to 1,000 miles/gallon or 20 miles for 5p. Battery replacement costs average 0.5p/mile and maintenance, at six-month intervals, is minimal.

Production assembly is by Hoover at its Merthyr Tydfil factory, under subcontract to Sinclair Vehicles, a private company set up by Sir Clive in February last year and is said to be financed by Sir Clive's sale of 10 per cent of Sinclair Research.

The initial production capacity is 200,000 units/annum. Similarly, the production capacity of the batteries, on a new line at Oldham's Denton factory, is also 200,000 units/annum.

Sir Clive expects to produce well over 100,000 vehicles this year, creating 200 new jobs at Merthyr alone and many others at component suppliers and, in what appears to be, a huge accessory market, ranging from horn and indicators (wiring already included in the basic vehicle) to designed-style weather cheaters.

Throughout the development of the C5, Sir Clive was deeply concerned about the safety aspects of the vehicle. He points out that during the day the light colour of the body makes the C5 highly visable. At night the large front and rear lights plus the high-intensity 3M reflector tapes, which are incorporated into the body, and other reflectors set into the wheels, make the vehicle easily seen.

Although the average C5 driver's eye level is the same as in a Mini, a high mast reflector is available as an accessory. Three wheels instead of two make the vehicle more stable and safer than a bicycle and the driver can jump clear more easily. In addition the vehicle takes up no more road width than a bicycle.

The Royal Society for the Prevention of Accidents has produced a road safety booklet for the C5. The Department of Transport, AA and RAC have been consulted on safety, and road awareness courses are being prepared.

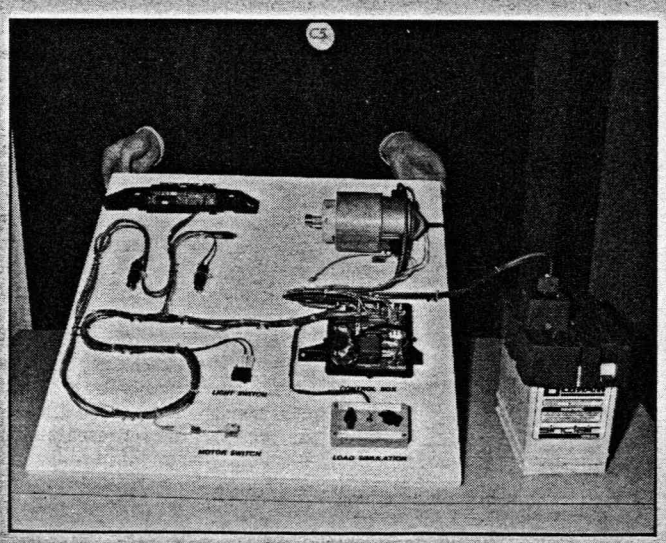
According to Barrie Wills, managing director of Sinclair Vehicles, production models have been driven for long periods on real roads at night to test traffic compatibility.

Comprehensive insurance terms have been prepared by the Prudential and range from £25/annum for drivers over the age of 30 to £50/annum for 14 year olds.

The complete vehicle and all the components have undergone exhaustive testing. For example, the steering system has completed one million mechanical test cycles, and several vehicles have been put through road tests equivalent to three years (5,000 miles) of continuous driving on rough roads including sharp inclines. The TTRL, MIRA and Lotus have been involved in many of these tests. □

## Control system for the C5 electric drive

The basic components of the drive control system are a Ferranti custom-made uncommitted logic array chip and an Ital Amec relay which are assembled on a printed circuit board by AB Electronics. This controller includes protection against motor overheating. A separate system will trip the drive if high currents are drawn for too long. To ensure long battery life, and provide a reserve for the vehicle's front and rear lamps, the drive is tripped when the battery has been discharged by 80 per cent.



Regenerative braking is not included and there is no reverse and no motor speed control. The motor is either On or Off. The vehicle can be edged forward slowly either by using the pedals, or by intermittent switching of the motor or by allowing the vehicle to free-wheel.

The instrumentation panel, also supplied by AB Electronics, has two LED displays, one for battery capacity remaining and the other for motor load.

The master battery switch clips onto the battery terminals and is operated, and locked onto the battery, by an ignition key.